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ABSTRACT

Some of the major studies by the proponents of the Derivational Theory of Complexity are reviewed in this paper, and the results of a study to determine the adequacy of the theory as an account of message processing difficulty are included. The subjects for the study were students selected from five sections of the introductory communication class at Michigan State University during the spring quarter of 1973. Despite the failure of this study to produce statistically significant results, the research demonstrates the existence of social class correlates of language processing and suggests the need for the inclusion of socioeconomic variables in psycholinguistic research. (RB)

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A PSYCHO-SOCIOLINGUISTIC ACCOUNT OF THE COMPREHENSION OF SPOKEN ENGLISH MESSAGES

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Psycholinguistic research has as its primary objective the construction of an empirically verifiable theory of language use or linguistic performance; one capable of accounting for the way individuals learn, produce and understand linguistic messages (Clark, 1965). A key point of contention within this area of research is the Generative-Transformationally based Derivational Theory of Complexity. This theory holds that;

> "...the more linguistic (ie. transformational) rules that a user would have to use in a given situation, the greater would be the demands upon his language-processing behavior." (Williams, 1972, pp. 92)

This paper reviews some of the major studies conducted by the proponents of the Derivational Theory of Complexity, examines the chief criticisms leveled against this body of research and reports the results of a study conducted by the authors pertaining to the adequacy of the theory itself as an account of message processing difficulty.

Background

The main goal of Chomsky's (1965) theory of Generative-Transformational grammar is to specify a minimal set of rules which will allow the ideal speaker-hearer to encode and decode linguistic messages. He argues that his account of syntax is particularly useful to the psycholinguist because it provides a finite set of syntactic rules which can generate an infinite number of grammatical utterances.

Although Chomsky (1968) maintains that his theory of linguistic competence does not apply to the actual language user, psycholinguists were quick

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to suggest that these syntactic rules, perhaps due to their unique sentence generating capacity, might correspond to the actual cognitive mechanisms underlying linguistic performance.

The earliest test of the correspondence between transformational complexity and sentence processing abilities was conducted by Miller, McKean and Slobin (1962). They presented subjects with several sets of test stimuli, each consisting of two columns of sentences. Subjects were asked to match sentences in one column with designated transformationally altered counterparts in the other. Counterpart sentences differed by one (either Passive or Negative) or two (both Passive and Negative) transformations. Subjects were then timed as they made the correct matches. As predicted, it took subjects longer to match sentences that differed by two transformations than those that differed by only one.

Concerned that the original investigation did an ineffective job of separating the amount of time a subject needed to decide what the required transformed sentence should look like from the time required to locate it in the search list, Miller and McKean (1964) replicated it. This time, after subjects had been informed of the transformed version of the sentence they were seeking, the stimulus sentence appeared on a tachtistoscope. Only after he had decided what the required transformed version should look like, by performing that transformation himself, did the subject press a button which called up the search list and stopped a timer which had measured the time elapsed since the presentation of the stimulus sentence. In this way, processing and search times were effectively separated. The findings of this study were substantially the same as those of the original.

Employing approximately the same set of transformations used by Miller, et al. and Miller-McKean, Mehler (1963) presented subjects with sentences requiring zero, one or two transformations. In measuring verbatim sentence recall, his findings were consistent with those of the two studies discussed above. That is, sentences with no transformations were accurately recalled more often than those with one transformation; and in turn, those with one transformation were more accurately recalled than those containing two transformations.

Here, again, a replication was performed (Mehler and Miller, 1964), and the results obtained were essentially the same as those of the original study.

While the studies reviewed thus far used fairly simple sentences as stimuli, Miller and Isard (1963) were able to deal with extremely complex sentences by varying the number of embedded clauses (between zero and four) in each while holding the number of words constant. Although there was not a one-to-one correspondence between the number of transformations employed in a sentence and the number of embedded clauses (some embeddings required more than one transformation), one variable was, nevertheless, a direct reflection of the other. Subjects were asked to memorize stimulus sentences and their recall accuracy was measured over five successive trials. As suspected, there was an inverse relationship between the number of embedded clauses and the accuracy of recall. While no subjects had recall problems with single embeddings, all subjects encountered difficulty in the three and four embedded clause conditions. The authors attributed these findings to the amount of memory space available for dealing with the syntax of the

stimulus sentences (Miller and McNeill, 1969, pp. 3:701).

A more direct test of the Derivational Theory of Complexity dealing specifically with the relationship between transformational complexity and memory space requirements was conducted by Savin and Perchonock (1965). Subjects were presented with a sentence containing between zero and three transformations followed by a list of eight unrelated words. Their task was to first recall the sentence and then as many of the eight words as possible. Estimates of the amount of memory space required to deal with the sentence were made on the basis of the number of unrelated words recalled. The greater the number recalled, the less space required for the sentence itself. The data indicated that multiple transformational requirements significantly exceeded single transformational requirements for memory space.

Considered as a whole, the findings of the studies reviewed above and similar studies showed quite clearly that as the transformational complexity of a sentence increases, receivers' ability to rapidly and accurately process it decreases. These findings, of course, are in agreement with the general predictions of the Derivational Theory of Complexity.

While these studies are noteworthy for the consistency of their results, they have all been critized on several grounds.

The first major criticism is that these studies (particularly those dealing with sentence processing time) concentrated on syntactic considerations to the exclusion of semantic factors which may have acted as confounding variables. Using an affirmative-negative shift is an obvious example of an instance where not only the syntactic complexity but also the meaning of the sentence is altered. According to current Generative-Transformational

theory (Jacobs and Rosenbaum, 1968), transformations, by definition, are meaning preserving, thus indicating that conceptually the affirmative-negative shift should not be considered a true transformation. Because, however, the affirmative-negative shift was used operationally in these studies, subjects may have taken longer to process the semantic differences between sentences than to process additional syntactic complexity. Re-examination of the Miller, et al. and Miller-McKean data would provide little information at best since all but a few of the comparisons tested involved the questionable affirmative-negative shift. Furthermore, little is known about how less noticable changes in pre-supposition might affect subjects' performance.

The second major criticism, one most often leveled against the sentence recall studies, is that during preliminary instructions subjects were informed as to the exact nature of the experimental task in which they were about to participate. It has been argued that subjects may have consciously attempted to memorize sentences without actually attempting to resolve their meaning as they would undoubtedly do in normal communication situations. If this were the case, these studies very probably indexed something entirely different from transformational behavior.

The third major criticism is that in all of these studies transformational complexity was investigated solely within the context of single sentences. Given only a single sentence at a time, subjects may have been able to deal with its formal grammatical aspects in far greater detail than they would typically have time to do in normal message decoding. Moreover, a number of other message related variables may come into play when decoding more than one sentence at a time which are either not present or are of no particular

importance when only single sentences are being processed.

In spite of the apparent legitimacy of the above three criticisms, a review of the recent literature pertaining to the Derivational Theory of Complexity reveals that they have only rarely been taken into consideration. One exception is a study conducted by DeVito (1969). Its importance lies not so much in its findings (which were somewhat inconclusive) but in the techniques employed to circumvent the three previously noted weaknesses in research on the Derivational Theory of Complexity. First, two stimulus messages were created each consisting of several sentences. Second, one version of the message consisted solely of simple-active-affirmative sentences, while the other version consisted of the same sentences in passive form. Exclusive use of the meaning preserving Passive Transformation to create the more transformationally complex message version insured that both versions were exact meaningful paraphrases of one another and thus reduced the possibility that syntactic and semantic factors would become confounded. Third, subjects were not told the nature of the experimental task until after they had been exposed to the treatment messages.

Cloze Procedure was used to test the general hypothesis that as the overall transformational complexity of the message increases, a receiver's ability to successfully comprehend that message decreases. DeVito found that subjects exposed to the passive message version had the highest mean Cloze comprehension scores when verbatim fill-ins were scored. When correct form class fill-ins were scored, he found that subjects exposed to the simple-active-affirmative message version had the highest mean Cloze comprehension scores.

At first glance, these findings seem somewhat contradictory to the predictions of the Derivational Theory of Complexity. However, they can be explained by a factor other than transformational complexity; that factor being lexical redundancy. In passive sentences, little words such as "was", "were" and "by" always appear. As DeVito has suggested, once subjects recognized the recurrent pattern of such words in the sentences of the passive message version, correctly supplying them in Cloze Procedure became an easy task. For the simple-active-affirmative message condition, the redundancy was a syntactic rather than a semantic phenomenon. In an attempt to make the message grammatical in Cloze form, subjects had only to choose from words within a very limited number of form classes thus making the probability of success quite high. We are left to conclude that while DeVito had successfully avoided some of the pitfalls of earlier work, his study did not constitute a direct test of the Derivational Theory of Complexity.

The present study, which attempted such a test, differed from DeVito's in the following respects. First, four messages were developed for use as stimuli rather than just two. These messages differed from one another in overall transformational complexity and total number of words but did not vary in meaning or total number of sentences. Version #1 contained sentences which most resembled true kernels due to the fact that no optional transformations were applied. In Version #2, one optional transformational operation was applied to each of the Version #1 sentences resulting in a combined total of twenty transformations. In Versions #3 and #4, two and three optional transformations, respectively, were applied to the sentences of Version #1. This resulted in totals of forty and sixty instances of

transformational rule applications being present in Versions #3 and #4, respectively. A list of those transformations used in the manipulation is presented below:

Passive	Prepositional Phrase Preposing
Adverb Preposing	Extraposition of Noun Phrase Complement
Dative	"Each" Hopping
Particle Movement	Prepositional Phrase Embedding
Time-Place Deletion	Agent Deletion

Second, a verbatim fill-in scoring scheme was used exclusively to measure comprehension.

In the present study, a number of independent variables were employed in addition to the number of transformations in the various versions. These included the following information about each subject: age, sex, year in college, size of community in which he spent the first ten years of his life, whether or not a language other than English was used by him in his home, mother's educational level, father's educational level, and the occupational prestige and income of the parent who provided the primary means of support for his family. These variables were included in order 1) to measure the relative efficacy of using derivational complexity alone as an indicator of message processing difficulty, and 2) to measure the extent to which a combination of psychological and sociological factors could account for observed behavior.

Methods and Procedures

Five intact groups of students, selected from sections of the introductory communication class at Michigan State University during the Spring Quarter of 1973, served as subjects. Treatments were randomly assigned to these groups.

One group, used to provide a baseline comprehension measure for the remaining groups, completed the Cloze test for Version #1 without hearing the version. Subjects in this group had a mean percentage accuracy score of 44%, far enough below the means of the other groups to provide assurance that there was a treatment effect. The data collected from this baseline comparison group was not included in the statistical analysis discussed below.

Upon entering the experimental setting, subjects were introduced to the Experimenter and told that their task was to complete a questionaire after they had listened to a tape recorded message. After hearing the tape, subjects were given the test booklets and instructions for completing the Cloze Procedure. Ten minutes were allotted for completion of this portion of the instrument after which subjects completed the socio-economic and demographic items. One hundred thirteen subjects took part in the study, however, eleven of these failed to complete a major portion of the instrument, a task which took most subjects about half of the allotted time. For this reason, these eleven were eliminated from the subject pool. In order to achieve equal n's per cell, one subject each was randomly eliminated from the groups exposed to Versions #2 and #4.

Results

The means and standard deviations of the variables are presented in Table 1. In view of the unequal number of blanks in the Cloze tests administered in the four experimental groups, the scores were converted to a 100 point scale having a mean of 56.11 and a standard deviation of 11.75. This would indicate a substantial overlap in the distribution of the experimental

and control groups. The individual experimental group means did, however, array themselves as expected with greater message complexity producing lower mean scores.

Table 1 About Here

The zero-order correlation matrix of the independent and dependent variables is given in Table 2. The only independent variable correlating significantly (alpha = .05) with the Cloze score was mother's educational level. Conspicuous by its lack of significance is the primary derivational complexity variable, number of transformations. An examination of Table 2 reveals also that a number of variables frequently employed in sociolinguistic research (e.g. community size) failed to demonstrate correlations of any magnitude. All significant correlations are indicated in the table by an asterisk.

Table 2 About Here

Table 3 contains the results of the regression of the Cloze Procedure scores and the independent variables. The analysis produced a multiple correlation of .469 and an F of 1.722; at alpha = .05 (two-tailed), F required for significance is 1.99. Those variables with substantial beta weights were age, mother's educational level and occupational prestige. However, the variables which accounted for the greatest portion of variance when entered in the regression equation were mother's educational level, occupational

prestige, and number of transformations. The addition of socio-economic and demographic variables to the derivational complexity variable increased the variance accounted for by 17.87%.

Table 3 About Here

Discussion

The failure of this study to produce statistically significant results can be explained by two features of the study itself. First, sociolinguistic research has been able to specify the direction of the relationship between socio-economic variables and certain language abilities. For example, the higher the subject's social class, the more likely he is to encounter and deal with more complex sentences. Thus, we might expect him to have greater language comprehension abilities than the lower social class subject simply on the basis of his past experiences with his language. This perspective was not employed in this study in the form of one-tailed hypotheses predicting the relationship between the ability to comprehend sentences of differential complexity and social class. Had this been done, the results would have been statistically significant.

Second, the disparity between control and combined experimental group means is small. In other words, subjects in the control group were able to insert the correct word in the Cloze Procedure almost as well as the subjects who actually heard a message. This may have resulted from the use of college student subjects. Whatever the cause, any replication should administer the Cloze tests for all messages to control groups and use their scores, possibly

by weighting the predictability of individual items, to derive a more reliable measure of sentence comprehension. In spite of these weaknesses, the results do indicate that psycholinguists and sociolinguists can benefit from an examination of one another's research strategies.

Recent sociolinguistic research has focused less on linguistic codes and more on educability and role systems. The efficacy of this shift is questionable given the scheme now used to distinguish elaborated and restricted codes. It is difficult to see how the use of conjunctions and the frequency of impersonal pronoun usage, for example, can account for the magnitude of differences in educability found by sociolinguists. By incorporating the derivational complexity model in their research, sociolinguists could contrast the linguistic codes on more sound theoretic underpinnings than they do at present.

Psycholinguists have shown that "decoding of sentences into kernels or deep structures has a certain psychological reality" (Greene, 1972, pp. 136). The present research demonstrates the existence of social class correlates of language processing and argues for the inclusion of socio-economic variables in psycholinguistic research. Such a strategy could only enhance the predictive ability of psychologically based theories of language behavior.

Table 1
Means and Standard Deviations

	$\bar{X}$	S.D.
1. Number of Transformations	2.50	1.13
2. Cloze Score	56.11	11.75
3. Sex	1.50	0.50
4. Year in College	1.76	0.93
5. Age	2.33	1.34
6. Community Size	3.88	1.65
7. Foreign Language Usage at Home	1.09	0.28
8. Mother's Educational Level	12.86	2.63
9. Father's Educational Level	13.42	3.75
10. Occupational Prestige	68.62	11.91
11. Breadwinner's Income	2.67	1.78

Table 2

Zero Order Correlations

#	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	-.20	1.00									
3	-.09	-.10	1.00								
4	.22	-.12	-.10	1.00							
5	.05	.01	-.06	.52*	1.00						
6	-.04	.06	.07	-.17	-.11	1.00					
7	.13	-.14	.04	.03	-.08	-.17	1.00				
8	-.16	.33*	.01	-.31*	-.42*	.22	-.14	1.00			
9	-.07	.19	.19	-.26*	-.34*	.10	-.10	.64*	1.00		
10	.07	.02	.12	-.07	-.10	.22	-.11	.52*	.57*	1.00	
11	-.03	-.16	.00	-.02	.11	-.21	.03	-.53*	-.54*	-.71*	1.00

Table 3
Regression Coefficients
Predicting Cloze Score

	Unstandardized Regression Coefficients	Standardized Regression Coefficients
Number of Transformations	-1.10	-0.11
Sex	-1.98	-0.08
Year in College	-1.23	-0.10
Age	2.11	0.24
Community Size	0.00	0.00
Foreign Language Usage at Home	-2.62	-0.06
Mother's Educational Level	1.77	0.40
Father's Educational Level	0.39	0.11
Occupational Prestige	-0.32	-0.32
Breadwinner's Income	-0.98	-0.15
	$R = .469$	$R^2 = .220$

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